Electronic Supplementary Material (ESI) for Nanoscale.

Supporting Information

Drawing WS_2 thermal sensors on paper substrates

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Comparison between the performance of WS_2 and graphite on-paper thermoresistive devices

Measurements on different WS_2 devices

Optical characterization of the WS_2 film on paper

Raman characterization of the graphite electrode drawn on top of the films

Characterization of the electrical properties of a WS_2 film on paper

Resistance vs. temperature of device shown in Figure 4 in log scale

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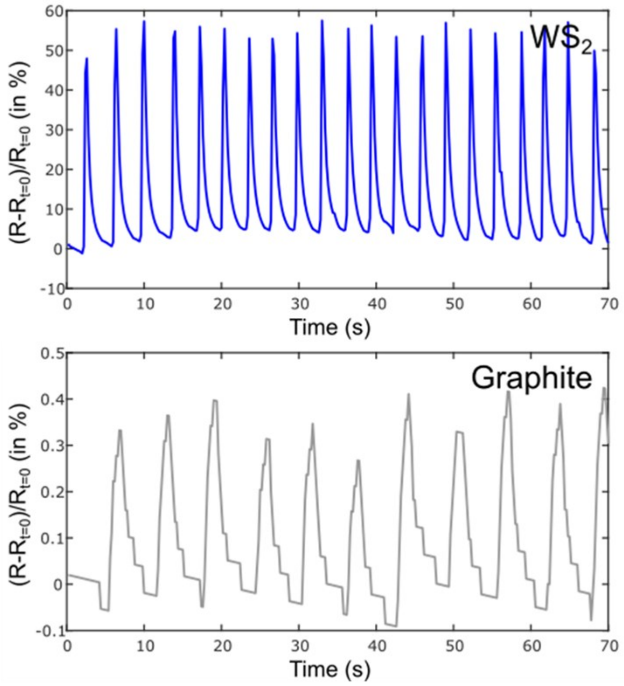

Figure S1. Comparison between the response of WS_2 and graphite on-paper thermoresistive devices upon sudden temperature changes. The devices are warmed up at ~45-55 °C and a hand pump blows pulses of cool air onto the device that show up as increases in resistance. Note the big difference in the vertical axis for the different materials.

Measurements on different WS_2 devices

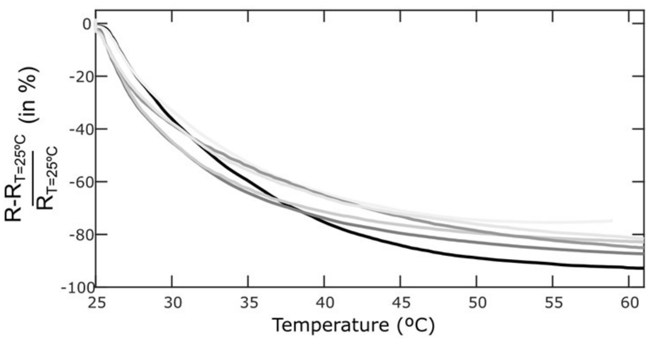

Figure S2. Change in the resistance vs. temperature for 6 different WS_2 devices. Note that the devices were intended to span over a wide range of thicknesses. In fact, their room temperature resistance varies between 0.7 MΩ and 20 MΩ. Despite the difference in device resistance the resistance change is rather reproducible in all the devices.

Optical characterization of the WS_2 film on paper

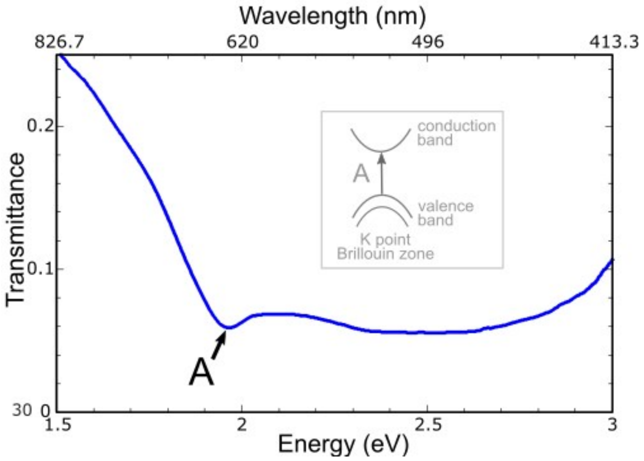

Figure S3. Transmittance spectrum of a WS_2 film on paper. The differential transmittance (normalized with respect to bare, uncovered paper) of the WS_2 film shows a prominent peak at ~1.95 eV that agrees well with the one observed in multilayer WS_2 flakes. This peak is attributed to the resonant absorption for photons with the energy matching the direct band gap transition A at the K point of the Brillouin zone.

Raman characterization of the graphite electrode drawn on top of the films

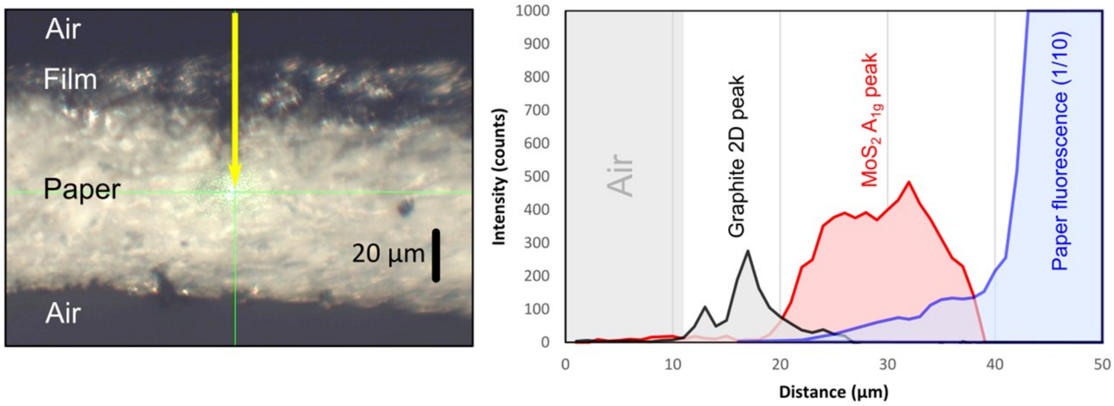

Figure S4. Characterization of the interface of a graphite electrode drawn onto a MoS_2 film on paper. (left) Optical microscopy image of the film/paper cross-section studied by Raman spectroscopy. The yellow arrow indicates the approximate line scan measured. (right) Intensity of the different Raman peaks as a function of the distance. The line scan starts outside the sample and at ~10 µm the signal from the graphite 2D peak starts to be measurable. The MoS_2 signal (A_{1g} peak) starts to increase when the graphite signal drops. The paper fluorescence signal is also plotted showing how its intensity increases dramatically once the MoS_2 signal drops. The spot-size used in this measurement is ~5 µm in diameter which would explain the intermixed signal between the graphite and MoS_2.

Characterization of the electrical properties of a WS_2 film on paper

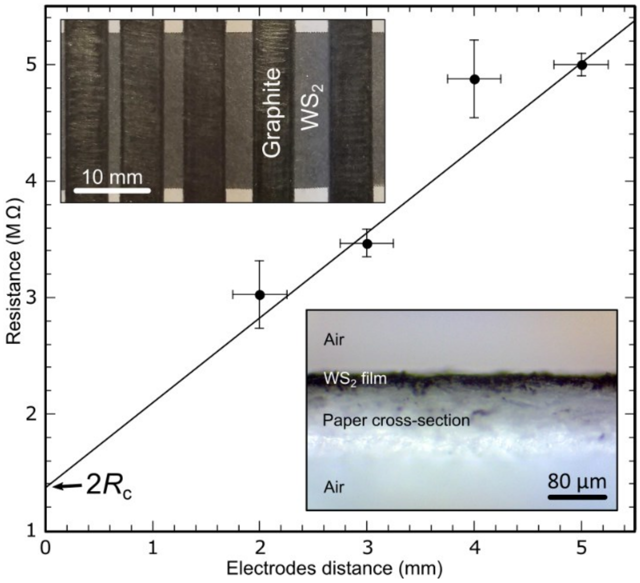

Figure S5. Transfer length measurement to determine the contact resistance and conductivity of a WS_2 film on paper. A long bar-shaped WS_2 film is drawn on paper (20 mm wide, 20 ± 5 µm thick) with graphite electrodes with different electrode spacing. The insets show a picture of the device and a cross-section optical microscopy image of a cross-section of the WS_2 film on paper to determine the thickness. The resistance between different pairs of electrodes are measured. The contact resistance (R_c = 0.7 MΩ) is extracted from the crossing of the linear fit with the vertical axis. The conductivity of the film (G = 3.5 ± 1.3 mS/m) is extracted from the slope of the resistance *vs.* electrodes distance linear trend and the device geometry.

Resistance vs. temperature of device shown in Figure 4 in log scale

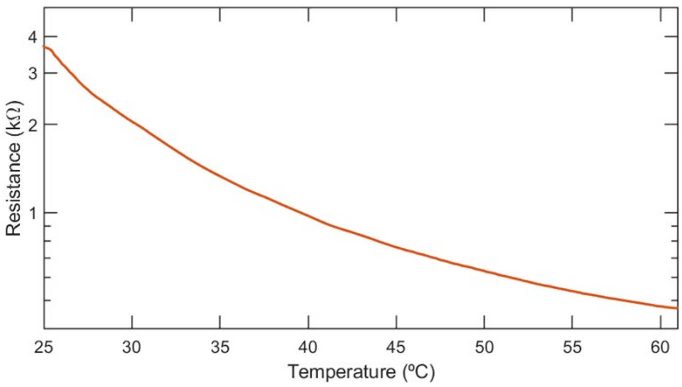

Figure S6. Resistance vs. temperature characteristics of the thermoresistive device shown in Figure 4 of the main text but in log-scale to demonstrate that it cannot be fitted to a single exponential decay.